

STANDARD SPECIFICATION FOR NEUTRAL GROUNDING RESISTOR (NGR)

A. APPLICATION AND DETAILED TECHNICAL SPECIFICATIONS

NGRs are used in industrial Power Systems for resistance grounding of star connected generators and transformers. NGR is connected between ground and neutral of transformers, generators, busbars and grounding transformers. NGR limits the faults current to value enough to operate protective relays, thereby preventing unwanted damage to the system.

CONSTRUCTION

The NGR unit shall consist of two parts: 1) the resistor grid enclosed in a metallic enclosure, and 2) the NGR monitoring system, enclosed in a separate chamber of the same enclosure/panel.

1) Resistor and resistor enclosure

a) Resistor assembly

The resistive element/grid material shall be low temperature coefficient, resistor grade stainless steel, resistor grade 1JR (or Cu-Ni, Ni-Cr or Fechril) of sufficient mass to withstand the rated current and prescribed duty.

The resistive element/ resistor grid shall be made of unbreakable, corrosion proof jointless elements wire wound around a ceramic (or micanite) core supported on a porcelain pad.

The resistors shall be mounted in heavy gauge corrosion resistant support frames, using stainless-steel hardware. The entire resistor assembly shall be mounted and supported on glazed insulators rated for the system voltage. All resistor terminals and interconnections between resistor units shall be stainless-steel using stainless steel hardware including lock washers. High current connections shall be spot or TIG welded as appropriate. Connections between resistors and bushings shall be solid copper or stainless steel bars. The unit shall be designed to permit the expansion of supporting rods when submitted to high operating temperatures.

With lower quality resistance material (high temperature coefficient), the change in resistance value will be excessive. This may result in insufficient fault current to actuate the earth fault detection relay and the fault will stay on the system and eventually destroy the resistor and whatever distribution equipment it is protecting.

Resistor grid assembly mounting structure shall be properly supported to absorb vibration and stress during faults and transit.

Neutral cable shall be brought to one terminal of the NGR unit. The other end of the NGR unit shall be suitable for connection to ground through earth electrode. These end connections of the resistor unit will be brought out to terminal box or through top or side mounted high voltage bushings. Stand -off / support insulators shall be ceramic or epoxy resin cast.

The resistor grid shall be suitable for

Rated Voltage : $415/\sqrt{3}$ Volts

Rated Current : 750 mA
Rated Resistance : 330 Ohms
Time Rating : 10 Sec.
Temperature Rise : 375 Deg. C.
Location : Indoor
Tolerance : +/- 10 %
Degree of Protection: IP -33
Applicable Standard: IEEE -32: 1972

b) Resistor enclosure panel

Resistor grid assembly shall be housed in an enclosure made of heavy gauge sheet steel (= 2mm), self supporting and floor mounted, cubicle type, indoor, dust and vermin protected. Enclosure shall be supported on steel support channels, suitable for fixing with grouting bolts. Sheet steel shall be used on a rigid framework of suitably sized steel angles and channels, welded or bolted together with stainless-steel hardware. Front of the panel shall be hinged on the left side to serve as an inspection and service door, fitted with clamps and special non-deteriorating neoprene gaskets. Enclosure shall be provided with bolt-on louvered covers (fitted with fine wire mesh inside) on sides for circulation of air. The top of the enclosure shall be embossed with stiffening ribs. Lifting lugs shall be provided on the top of panels. Bottom shall be elevated to minimum 6 inches/15 cms above the base of the unit. Bottom shall be screened for maximum cooling of resistors. Suitable earthing studs are to be provided on two sides.

Protection rating of the enclosure shall be IP 42, using roof shaped louvers shielded with wire mesh (inside). A durable corrosion resistant nameplate permanently attached to one side cover shall show the manufacturer and the complete rating. Clear warning labels (danger, high voltage, earthing etc.) shall also be fixed at appropriate places.

Enclosures shall be suitably cleaned, primed and powder coated/ spray painted, colour of paint light gray to shade 631 as per IS: 5.

One strip type panel heater shall be installed in the resistor panel. The heater shall be provided with a adjustable setting thermostat.

Limiting Dimensions (L X B X H) = 600 mm x 500mm x 600 mm

2) NGR monitoring system

NGR monitoring system shall be placed above the resistor enclosure. Sufficient physical gap (minimum 10 cms) shall be allowed so that air will circulate freely above the resistor enclosure. Dimensions of the panel for NGR monitoring will be same as the resistor enclosure.

Functioning of the NGR MONITORING system is as follows:

Ground-fault protection, coordination, and annunciation systems depend on the integrity of the NGR. If the NGR fails, these systems become inoperative.

In addition, an open NGR causes the system to become ungrounded and exposure to transient overvoltages is possible.

Monitoring of the NGR shall include the following considerations:

- 1) Monitoring the NGR connections to the neutral and to the ground bus- for continuity (as resistors are unlikely to fault on short circuit)
- 2) Monitoring the neutral/NGR current through a residual current CT provided in the NGR path
- 3) Monitoring the neutral-to-ground voltage
- 4) Audio- visual annunciation of ground fault and NGR fault

The NGR monitor shall measure changes in NGR resistance, current in the neutral and neutral-to-ground voltage. The NGR monitor shall coordinate these three measurements and operate output contacts when an NGR fault or a ground fault is detected. NGR monitor shall respond to fundamental-frequency current and voltage, and it is not influenced by harmonics.

The output contacts shall be used to operate alarms (buzzer) and visual annunciation devices. Potential free output contacts (minimum 02 pairs) shall also be provided for future use, such as tripping of main breakers etc.

Main components of the NGR monitoring system shall include, but not limited to, the following:

- a) Monitor for Ground Fault & NGR (with band pass filter for frequencies other than 50 Hz)
- b) Coupling device/sensing resistor for NGR Monitor
- c) Residual current sensing C. T. for NGR Monitor
- d) Output relay with sufficient nos. of potential free NO and NC contacts
- e) Alarm indicator & operator panel with visual annunciation (with LED lamps) for NGR fault and ground fault and buzzer
- f) Incoming 230/240 V, 50 Hz AC supply with sufficiently rated HRC fuse for power supply to monitor panel

NGR monitoring system shall be housed in an enclosure made of heavy gauge sheet steel (= 2mm), self supporting, cubicle type, indoor, dust and vermin protected. The enclosure shall be supported on steel support angles/channels, suitable for fixing (with nuts and bolts) on top of the NGR housing panel. At least 6 (six) inches gap shall be maintained between the top of the NGR housing and bottom plate of the NGR monitoring system panel, for maintaining air flow. Sheet steel shall be used on a rigid framework of suitably sized steel angles and channels, welded or bolted together with stainless-steel hardware.

Front of the monitoring panel shall be hinged on the left side for easy access to the components inside and fitted with clamps and special non-deteriorating neoprene gaskets. The top of the enclosure shall be slightly overhung and sloped. It shall be embossed with stiffening ribs. Lifting lugs shall be provided on the top of panels.

Suitable earthing studs are to be provided on two sides. Protection rating of the enclosure shall be minimum IP 53. A durable corrosion resistant nameplate permanently attached to one side cover shall show the manufacturer and the complete rating. Clear warning labels (danger, high voltage, earthing etc.) shall also be fixed at appropriate places. Enclosure shall be suitably cleaned, primed and powder coated/ spray painted, colour of paint light gray to shade 631 as per IS: 5.

The buzzer and LED indication lights/test/reset buttons shall be mounted on the front door. Suitable engraved, corrosion resistant legends shall be used for each component/function. Monitor windows for remote indicator alarm and operator panel will also be mounted on the door.

As the components of NGR monitoring system shall be wired up to the NGR, steel rigid conduits shall be used to run the signal cables from NGR to monitoring panel. It may be noted that residual current transformer (for sensing NGR current) and coupling device/sensing resistor may be required to be installed in the NGR panel for maximum effectiveness. Conversely, neutral cable shall be first routed through the monitoring panel and then to NGR. In such a case, the monitoring panel shall be provided with suitable bushings/ terminal box (as given in the description for NGR panel) for termination of the neutral cable.

Elements connected to the NGR are subject to line-to-neutral ground-fault voltages and must be evaluated in all failure modes. Coupling devices must not transfer hazardous voltages to associated monitoring equipment. Atmospheric electrical conditions, such as the presence of charged clouds, can affect an electrical substation feeding overhead lines. An NGR monitor used in this application must be immune to these conditions.

The measurements made by an NGR monitor can be useful when evaluating system problems. An analog signal can be used to provide local earth-leakage-current metering. An NGR monitor with a communications interface can allow data access with a local PC or with a network.

NGR Monitor panel Limiting Dimensions (L X B X H) = 600 mm x 500mm x 600 mm

Technical data for NGR monitoring panel components:

Components like NGR monitor, coupling device and current transformer shall be of one make only for compatibility, from either of the following manufacturers.

1) Bender, USA, 2) Startco/Littelfuse, Canada (Littelfuse SELCO- India), 3) i-Gard, Canada

a) Monitor:

(Model nos.: Bender- "RC48N" / Startco- "SE-325" / i-gard- "Sigma")

Supply voltage 230-250 VAC, 50 Hz
 Response value, voltage measurement adjustable from 20 V to 400 V
 Response value, residual current adjustable from 0.1 A to 10 A
 Response delay adjustable 0.1 s to 2 s
 Switching elements (alarm relay) 2 Form C contacts
 Rated contact voltage AC 250 V / DC 300 V
 Limited making capacity AC/DC 5 A
 Switching elements (GFA, NRA) 1 N/O contact each
 Rated contact voltage AC 250 V / DC 300 V
 Limited making capacity AC/DC 5 A
 Test of the electromagnetic compatibility (EMC)
 Immunity according to IEC 62020
 Emissions according to EN 50081
 Emissions according to EN 55011/CISPR11 Class A

b) Coupling device/sensing resistor for NGR Monitor: As per manufacturer's design and catalogue

c) Residual current sensing C. T. for NGR Monitor

Internal dia: ≥ 70 mm

Rated voltage: >800 V

Rated primary residual current: 10 A

Rated secondary residual current: 0.01 A

d) Output relay with sufficient nos. of potential free NO and NC contacts
 The relay shall be used for initiating audio-visual alarm (or shutdown of the main breaker of generator or transformer). Relay shall be contactor type. No plug-in type relay shall be used.

The make of the relay shall be Telemecanique (model TeSys, D or K model)/GE/Siemens/ Legrand/L & T/ABB/Indo-Asian/T & C

e) Alarm indicator & operator panel with visual annunciation for NGR fault and Ground fault and buzzer

Suitable alarm indicator and operator panel with LED indication lamps for Ground fault and NGR fault annunciation and push buttons for test and reset functions along with buzzer shall be installed in the monitor panel.

Visual annunciation for NGR fault and ground fault will be through LEDs (labeled "NGR Fault" and "Ground Fault").

LEDs shall be of suitable voltage, size 22.5 mm. Make-Siemens/ L&T/ BCH/ Binay/Schneider.

Audio annunciation will be through a buzzer mounted inside the monitor panel.

Buzzer shall be suitably rated for continuous duty. Buzzer supply shall be of suitable AC voltage. Make- Siemens/Schneider/BCH/L & T.

LEDs and Buzzer shall be mounted on the front door of the monitor panel.

Test and reset buttons on the front door of monitor panel shall be provided for testing of the NGR and GFA test circuits from the NGR monitor.

Test and reset buttons make-Siemens/Schneider/BCH/L & T.

Reset button will silence the buzzer, but the LEDs will remain on till the time fault is detected and cleared.

The indication LEDs and test and reset push buttons on the front door shall be in addition and external to the G/F & NGR monitor (which may have these functions built-in).

f) Incoming 230/240 V, 50 Hz AC supply with HRC fuse base and link for power supply to monitor panel

Power supply to the monitor panel shall be through suitably rated HRC fuse link, MCB and transformers (if required to step down to the voltage level of monitor panel components supply). Separate circuits through fuses shall be used for the monitor and audio-visual annunciation panel.

Moulded HRC fuse holders with suitably rated fuse links; make-GE/Schneider/Bussman.

MCB make: Legrand/Telemecanique/Havells/ABB.

Control transformer make: AE/L&T/Kappa/Reputed.

Separate isolation fuse link and an MCB shall be provided for switching power supply to NGR space heater. Space heater shall be controlled through an adjustable thermostat.

3) General:

a) Control wiring shall be done with 1.5 sq mm, flexible copper, 1100 V grade PVC insulated wires approved by ISI, TAC, FIA. All wiring will have tinned copper lugs & terminal blocks as required. Wiring for the residual current CT shall be done with 2.5 sq mm, flexible copper, 1100 V grade PVC insulated wires approved by ISI, TAC, FIA & have copper lugs. Colour code for wires shall be followed as per IS. Ferrules shall be provided for identification of cables. Make of cables: Finolex/Havells/L&T or other reputed make.

b) All components shall be labeled for easy identification with metallic embossed identification tags.

c) Panels shall be duly tested as per IS: 8623 at manufacturer's works and routine test certificate shall be submitted at the time of final inspection.

4) Special Notes:

a) Vendor of NGR system must submit type test certificates for the following tests for their designed and NGR panels as per IS: 8623 (with latest amendments) from a test house/ laboratory accredited by National Accreditation Board for testing and calibration Laboratories (NABL), India.

i) Short time current withstand test (50 kA for 1 second)

b) The following Documents / drawings shall be submitted for approval:

i) GA drawing of the NGR with enclosure and NGR monitoring panel

ii) Technical literature of NGR and NGR monitoring system

iii) Detailed power & control wiring diagram

- iv) Component layout drawing showing all components
- v) Bill of materials of all components.
- vi) O&M manual for NGR and Monitoring panel.

C. GENERAL NOTES FOR ELECTRICAL ITEMS AND WORKS:

The manufacture of the unit shall start only after written approval of the drawings/ documents by OIL.

D. SPARES

Following spares shall be supplied by the vendor along with the NGR units.

1. Monitor for Ground Fault & NGR- Min. 1 (one) no.
2. Coupling device/sensing resistor for NGR Monitor- Min. 1 (one) no.
3. Residual current sensing C. T. for NGR Monitor - Min. 1 (one) no.
4. Output relay with NO and NC contacts- Min. 2 (two) nos.
5. Colour LEDs (complete) set for "NGR Fault" and "Ground Fault" indication- 12 (twelve) nos. each

E. INSPECTION AND TESTING

All the routine tests of the NGR monitor and NGR monitoring panel shall be witnessed by OIL engineers at manufacturer's works. The routine test will include the following minimum tests/measurements:

1. Physical checks & Operation check of all components
2. HV test of monitoring panel
3. Insulation tests (before and after HV tests).

F. COMMISSIONING

1. Installation and Commissioning of the NGR units shall be carried out by the vendor/supplier as per NEC, IS, CEA Regulations at site. Services of qualified and competent personnel of supplier are essential during commissioning of the sets. All tools, instruments, test kits, drill machine, vice, hardware, clamps etc. required for the job shall be provided by the supplier. Operational tests of all devices including their settings shall also be carried out during commissioning job by the supplier.

2. Copper bonded steel/Chemical earth electrodes shall be used for obtaining as minimum earth resistance as possible. PVC insulated aluminium cables shall be used for connection of the neutral point at the NGR unit to the earth electrode.

G. GUARANTEE

NGRs and monitoring panels shall be guaranteed for 12 months after commissioning or 18 months after supply, whichever is earlier.